# THE STUDY OF INDIAN BIRDS.

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## PART IX.

(*With a plate and a text-figure.*)

(*Continued from page 324 of this volume.*)

### THE REPRODUCTION OF BIRDS.

#### *The Egg.*

There are many aspects to the study and interest of Birds and their lives; but it is quite safe to say that by far the most popular is that of their eggs. There is something peculiarly attractive about an egg itself. It is so clean and neat an object. It is often surprisingly beautiful, even apart from the perfect setting of its nest. To search for nests is to combine the pleasures of nature and of sport. A day's bird-nesting is a day spent in the open air. The careful search and the patient watching necessary for more than a mere occasional success brings one in touch with every aspect of nature. Exercise and pleasure and interest are all combined. Whilst the attainment of the specially coveted eggs may imply all the care and skill, the extended expeditions and the actual dangers of which the sportsmen's trophies too are only the symbol and memento.

The egg appeals also to the orderly mind of the born collector. A collection of eggs like a collection of stamps affords an outlet for all his instincts of neatness and acquisition. He is able to blow the egg neatly, label it neatly and arrange it with loving care and precision. The amassing of a large number is within the means of the most moderate income. The infinite varieties found in a single species provide an excuse alike for wholesale depredations and extreme specialisation.

It is therefore eminently pardonable, to use Professor Newton's words, for the victims of this devotion to dignify their passion by the learned name of 'Oology', and to bespeak for it the claims of a science. Though there can be little doubt that the study of Oology has not conferred benefits on scientific Ornithology at all commensurate with the number of its votaries and the time which they have spent on it.

However that may be, we are here concerned with the egg chiefly as an item in the story of the reproduction of birds.

We have already seen that one of the characteristics which Birds retain from their reptilian ancestry is the fact that they are oviparous, that is, produce their young through the medium of eggs. The eggs of many present-day reptiles are essentially the same as the eggs of birds, though the majority of them have not attained to quite the same degree of development in the formation of hard shells. The number of eggs laid in the clutch has with development decreased amongst birds.

Before describing the egg itself it is desirable to describe briefly the reproductive organs of the parents and give a brief summary of the development of the egg.

In both sexes of a bird the reproductive organs are situated against the upper wall of the abdominal cavity at the anterior end of the pelvis. This corresponds roughly to what in ourselves we should describe as the small of the back or the region of the kidneys.

In both sexes the organs consist of paired germ-producing glands and their efferent ducts, but it will be most convenient to consider the sexes separately.

In the male the testes are a pair of whitish-yellow glands, oval, globular or occasionally kidney-shaped or vermiform which lie at the anterior end of the kidneys. Within each testis there is a multitudinous multiplication of germ-cells from which the spermatazoa pass into a convoluted body known as the epididymis and thence into the main duct the *vas deferens*,[1] a narrow tube which extends along the inner wall of the abdominal cavity to the cloaca or vent. The ends of the two *vasa deferentia* are often slightly dilated to form seminal vesicles, that is store-chambers for the spermatazoa. The *vas deferens* is typically of a slightly zigzag character.

These parts of the male reproductive system should be clear after reference to the illustration (Fig 1). It must be understood that, except in the Ratitæ and certain other forms such as the Coracidæ and some of the ducks, the male bird has no penis. The end of the cloaca has to act for it.

During the breeding season, these organs, which at other times are very minute in size, become greatly enlarged. The testes in the House-Sparrow (*Passer domesticus*), for instance, grows from the size of a minute pin's head to that of a ground-nut, temporarily even displacing the usual arrangement of the intestine, liver and stomach. The two testes are then often rather different in size, and also sometimes in shape. The *vasa deferentia*, also increase considerably in length, the extra length forming a closely convoluted mass round the entrance to the cloaca, causing it to protrude and in some dried skins to assume a character and shape which lead to much misunderstanding.

In the female bird a pair of ovaries are developed in the same position as the testes of the male. With rare exceptions, however, the right ovary dwindles and disappears at an early stage of growth. The known exceptions are chiefly amongst the birds of prey and an example of the presence of a double set of ovaries will be easily found by any one who troubles to dissect the female of the Indian Shikra (*Astur badius*). It is not known why the right ovary should disappear in most species, or why it should be retained in the few exceptions. It does not appear to function and even when it remains the right oviduct remains quite vestigial.

The ovary consists of a mass of embryonic eggs, several hundred in number which may be described as presenting the appearance of a minute cluster of grapes.

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[1] Care must be taken to distinguish the *vas deferens* from the ureter which lies parallel with it.

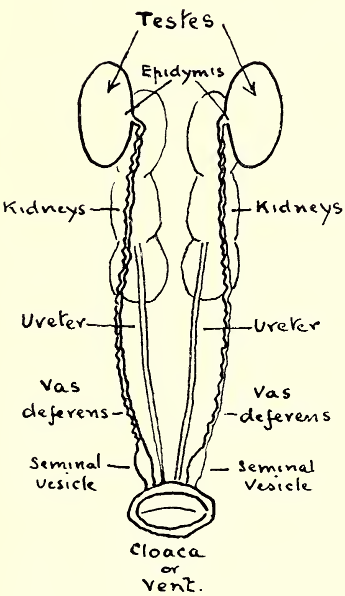


Fig 1
MALE ORGANS OF A BIRD.
(enlarged in the breeding season).

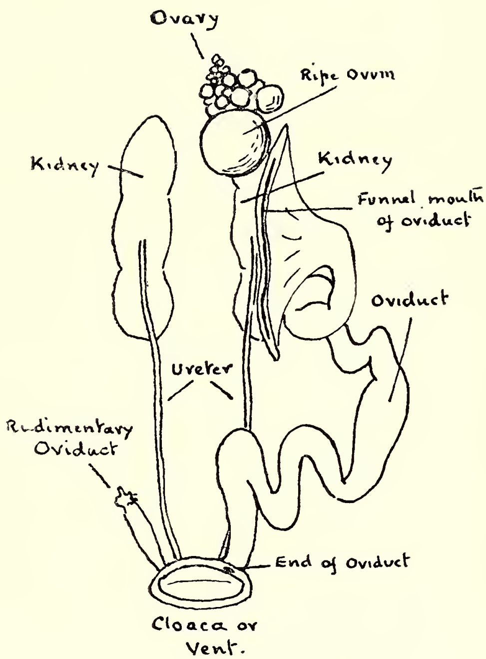


Fig. 2
FEMALE ORGANS OF A BIRD.
(enlarged in the breeding season).

The oviduct is a gut-like tube which passes from the neighbourhood of the ovary down to the left side of the cloaca. Its upper end is wide and trumpet-shaped, free in structure but in position pressed against the ovary. The lower end enters the cloaca close to its external entrance. (Fig. 2).

As in the male the female organs increase tremendously in size with the breeding season. The ovary which at other times may appear to the naked eye as a mere indistinct film with no granular structure becomes a big bunch of eggs in every stage of development from a microscopic object to a full-grown ripe ovum with a large amount of yolk. So with the oviduct. In the common Fowl, according to Gadow, the oviduct is normally six or seven inches long and scarcely a line wide; but at the time of laying eggs it becomes more than two feet in length and nearly half an inch in width. Its volume thus increases about 50 times, and this is an annual change with all wild species.

It is clear from the fact that both male and female organs lie dormant for part of the year and then exhibit a huge seasonal enlargement; that birds cannot indulge in coition and breed just when the fancy takes them. Their breeding is necessarily a seasonal affair, dependant on the development of the organs which must arise from either external or rhythmic stimulus. This stimulus, obscure in origin though it may appear to be, acts so far as we know on each sex separately.

If an observer in the Kashmir valley in spring makes a systematic collection of a series of starlings *(Sturnus v. humei)* which have returned there for breeding he will find that the males have the testes fully developed at the time when the female ovaries only show a slight enlargement.

At first thought one is inclined to think that this implies that stimulus from the male awakens the female. It is not so however. The male and female organs both awaken in response to a common external stimulus. The male however develops the more quickly because his function is required in the early stages of the eggs, before they have enlarged enough to bring the ovary to its maximum.

Being now, I hope, familiar on broad lines with the reproductive organs of both sexes we can proceed to consider the process leading up to the production of the perfect egg.

As any observer may see for himself the union of a pair of birds—insemination as it should properly be called—is a very brief affair, a matter of seconds usually. The purpose is of course the transference of the spermatazoa from the male to the female, but fertilization cannot be said to have taken place until the spermatozoa meet the ova themselves.

I am not competent to describe the minute and obscure processes involved in the reproduction of the young bird; but put briefly and generally, it is something like this.

The ovum (the female germ) and the spermatozoom (the male germ) each contain nuclear rods known as chromosomes. These are the vehicles of the hereditary equipment of the bird and they are set aside in the earliest stage of embryonic development, so that one may almost say that the 'hereditary formula' which makes the bird passes direct from generation to generation independent of the life history of the individuals. (It is on this fact that all the controversies as to the inheritance of hereditary and acquired characteristics hang.) In the ovum (while still in the ovary) and in the spermatozoon, these chromosomes divide as part of their normal maturation, and fertilization consists of the reunion of the chromosomes, half from the male germ and half from the female germ, to form again the complete unity which is then gradually clothed anew in a fleshly envelope, a fresh unit or segment of the generations which are the vehicle for the 'hereditary formula'. The mother body no doubt provides much of the raw material which forms the envelope, but it is clear from the fact that each parent provides half the chromosomes, how intimately and how subtly the young creature has exactly half its essential self from each parent.

The spermatozoa of birds are not similar in appearance for all species. They are of course exceedingly minute—it is said that a hundred can swim about in a drop of fluid suspended by the head of a pin—and they consist of three parts, a head, a centre and a long tail. The head contains the chromosomes. The centre contains a minute body called the centrosome. The tail is purely locomotive in purpose. Its moves drive the head along. It is in the nature of typical spermatozoa to move against a current. After insemination the spermatozoa left by the male in the cloaca of the female move, driven by their long tails, up the slight downward current of secretion in the female oviduct until they meet the ova. This may apparently be either in the mouth of the oviduct or in the ovary itself.

To return for the moment to the question of the ova. With the beginning of the breeding season the immature ova on the surface of the ovary start to accumulate yolk, that is nutritive fatty material which is brought to them by the blood and the lymph. They start irregularly so that many different sizes of immature eggs may be seen in the ovary. Then as an egg ripens it bursts from the capsule in which it grew and is caught by the trumpet-shaped mouth of the oviduct. At this stage either before, or generally after, the bursting of the capsule the egg is fertilized by the spermatozoa. If fertilization does not take place the egg may go through its normal development and be laid, all to no purpose. Or undeveloped and unfertilized eggs may be reabsorbed into the parent tissues and the ovary dwindles again until the new season again ripens the ova.

When the spermatozoon reaches the ovum its head pierces the envelope of the ovum and carries within it the chromosomes and the centrosome. The locomotor tail, having accomplished its purpose, is shed without as waste matter. The centrosome divides and becomes the centres of great protoplasmic activity, in other words become the stimulus to the growth of the embryo. The chromosomes, half of the male complement, unite with the present half of the female complement. The total is once more complete and the 'hereditary formula' (as I have called it to express in one both an idea and an entity) is fulfilled again ready to hand on through the next generation. Once a spermatozoon has entered an ovum, the outer surface of the ovum changes in character so that it becomes non-receptive to the entry of fresh spermatozoa. If this change is delayed, fresh spermatozoa may enter, and in some cases lead to the birth of monstrosities, by disturbing the work of the original centrosome.

We will now follow the history of the fertilized ovum. It burst from its capsule, we have seen, because of the pressure exerted by the continued accumulation of yolk and consequent increase in size. Occasionally the liberated egg may miss the oviduct and fall into the abdominal cavity. In that case it is usually reabsorbed by the peritoneal surfaces, though occasionally, and doubtless only if the bird is not in vigorous condition, a fatal disturbance is caused to the system. Normally however the egg is caught up by the trumpet-shaped mouth of the oviduct whose position with reference to the ovary generally ensures success.

In the oviduct the ovum or germ-cell becomes the egg as we know it. It is not necessary here to describe the oviduct or its processes in great detail. Suffice it to say that as the ovum passes slowly downwards, it is surrounded by various instalments of albumen (white of egg): it is surrounded by a shell-membrane and a calcareous shell; the shell is usually stained with pigments before it is finally set; and the manner of the deposition of these pigments, that is the markings of the perfect egg, afford some hint as to the order and time when they are laid on to the shell. The fact that the egg travels downwards with the broad end first explains why most eggs have the majority of their markings at that end and why a cap or a zone is so common a type of marking. Finally the perfect egg is expelled from the oviduct and through the vent and is henceforth separate from the body of the parent.

We are accustomed to attach a great deal of importance to the actual laying of the egg, and naturally so. At this point the egg appears in human ken. At this point it becomes of importance to the human being, whether as a matter of food or of interest. But strictly speaking, this stage is not of the same importance to the embryo itself. We have got to hold to the idea of one straight line of development starting with the maturation of the ovum in the oviduct and leading through an infinity of phases to the adult bird. The mysterious rhythm of life prepares the ovum ready for this line of development. The impetus to the start is furnished by the spermatozoon. Without it the matured ovum fades away again. With it the embryo unfolds like a plant from the seed. At the start it is housed in the ovary, then in the oviduct, then in the shelled egg, then in the nest; the final stages to maturity are passed as a complete bird. But we have to remember that the stage which is passed by the embryo in the shelled egg is no whit the more important to the embryo from the fact that its coffer then becomes, from utilitarian or æsthetic uses, of interest to the human being. To emphasize this, we have only to remember the case of the snakes and lizards. Some are oviparous and others viviparous, that is to say, the egg case may break within or without the body of the parent. Their whole clutch is often laid at one time, or at any rate in batches.

We attach a false importance to the egg, we are apt to consider it as the starting point of the embryo, for one very good reason. At this point nature usually applies the brake, and we witness the restarting.

Each egg is laid after an interval of 24 hours on the average. Occasionally the period is shorter. In some species the interval is 48 hours. The clutch of eggs is often quite large, say 12 or 14 eggs. The growth of a young bird is in its early stages particularly rapid. It is easy to see therefore that if each embryo continued its progress unbroken the safety of part of the brood would be greatly endangered. In cases of a large clutch—the long-tailed Tits of the genus *Ægithalus* for instance—some of the eggs would be still unhatched whilst the young from the earlier eggs would be almost ready to fly. The labour to the parents would be greatly increased and either the oldest or the youngest members of the brood would of certainty suffer and probably be lost.

Originally in the ancestral bird no doubt there was no halt in the development. The egg was laid in the herbage and rotting vegetation of the steaming primeval world and the incubation of the embryo proceeded unchecked by the transfer from the maternal body to the outer world. The same thing continues to-day, as we have seen, in the case of the Megapodes who immediately bury their egg deep in the mound of sand and vegetation and so retain its initial warmth.

The case of the Megapodes is however exceptional. The general rule is for the egg to be laid in the open and so experience a definite drop in temperature from the body heat of the mother. This drop in temperature retards the development of the embryo, just as all the functions of a hybernating butterfly or dormouse remain in abeyance during a fall in the temperature. If the drop is too low or too long the embryo must perish. A few families such as the Owls (*Strigidæ*) and the Herons and Bitterns (*Ardeidæ*) are accustomed to start to incubate with the laying of the first egg. The result is that in these cases there is no gap in the development of each embryo. The young in the nest are found in regular gradations of size, and their habits are such that no particular injury is inflicted on the broods, or trouble given to the parents by the different ages of the young. In these forms the character of the food and the comparative ease with which it is obtained, probably contributes to success.

The vast majority of birds, however, pay little attention to the nest or eggs until the clutch is complete. The newly-laid egg cools to the air-temperature. The embryo becomes torpid and all development is arrested. With the completion of the clutch the parent starts to incubate eggs in which the embryonic development has all been arrested at the same stage. The resulting nestlings all hatch about the same time, are of the same apparent age, and leave the nest about the same time. When they fledge and leave the vicinity of the nest, the parent is free to continue with them and often remains with them for a considerable period.

It may be of interest to describe the structure of the newly-laid egg (Fig. 3). Popularly we talk of the yolk, the white, the inner skin and the shell of an egg. These must be considered in greater detail.

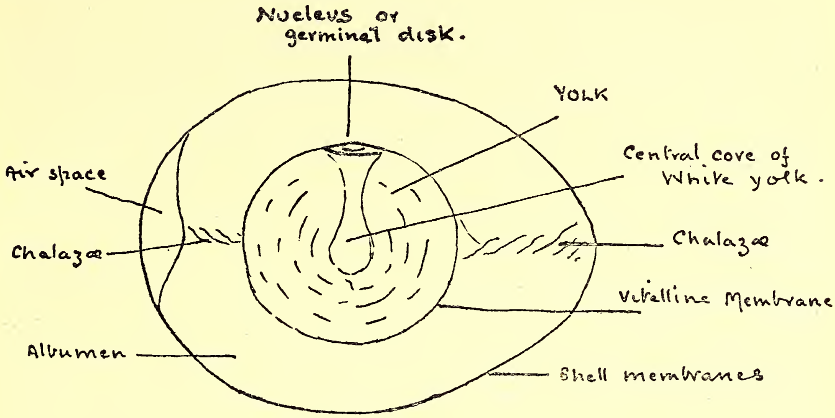


Fig. 1. Sketch of egg with shell removed.

The yolk consists of two different textures, known as 'white yolk' and 'yellow yolk' (though both of them are really yellow in colour). The white yolk contains a higher percentage of water. Reference to the figure will show that there is a central core of white yolk, funnel-shaped, and surrounded by yellow yolk in which there are alternating layers of the white yolk. On the top of the disk of the funnel core lies the nucleus or germinal disk of blastoderm out of which the embryo is to be developed. It is to be remarked that the yolk as a whole turns about within the egg so as to keep the germinal disk uppermost, whichever side the egg is lying on, so that it is nearest to the warmth of the incubating mother. This explains why the good poultry-keeper turns daily the eggs which are being kept for a setting, in order to insure that the yolk should retain its mobility against the time of need. The yolk with the germinal disk is contained within a vitelline membrane which is really the cell-wall of the original ovum dilated to contain the addition of the yolk which it received in the ovary.

The white or albumen is added in the oviduct. It consists of alternating dense and watery layers which give it a spiral arrangement. Some of the denser layers near the vitelline membrane extend as twisted cords (chalazœ) towards the two poles of the egg. They do not quite reach the outer layer of the white though the chord at the pointed end ultimately becomes somewhat superficially attached to the lining membrane of the shell. These chalazœ are elastic supports for the yolk and suspend it in position. The complete egg thus constituted is enclosed in the shell-membrane which consists of an inner and outer layer, both of which remain permanently in close apposition over the greater part of the egg and adhere to the shell. At the broad end they tend to separate and develop an air-chamber between them. This air-chamber does not exist in a perfectly fresh egg but is produced and increases as the bulk of albumen decreases by evaporation. This air-chamber explains why an incubated egg floats. The shell is finally deposited on the shell-membrane as a mamillary and porous layer, which in most species has also an outer cuticular layer. This outer layer is the most variable part of the shell and is responsible for the differences of texture which we find duly chronicled in all descriptions of eggs. It is apparently structureless ; if it is poor in calcine salts the egg is very smooth and shiny. If it is greatly infiltrated with calcareous matter we get the rough and chalky eggs of the cormorants (*Phalacrocorax*) and Grebes (*Podiceps*). In some forms it is entirely absent. This outer cuticle is spread over the entire surface of the egg, extending unbroken over and into the pits (or surface ends of the air-canals in the main shell) and therefore closing them. When dry, the cuticle is permeable by air, when wet, impermeable. The poultry-keeper who uses 'water-glass' to preserve his eggs is therefore merely keeping out the air by a sterilized layer of water and so arresting the ordinary process of decay.

The actual colour of the egg is produced by pigment-corpuscles,[1] which may be deposited in various levels of the shell. The pigments are deposited by the oviduct during the formation of the shell and cuticle and they may be deposited according to species in any or every strata. The colour in the innermost layer may not be visible until the blown shell is held up to the light. As the colour and pattern of the egg are deposited by secretions from the oviduct, it is not curious that there is distinct resemblance between the eggs of one clutch and the various clutches laid by an individual bird. The poorly-marked and pale egg so often found in a clutch is usually either the first egg (before the pigment secretions are fully working) or the last (when they are becoming exhausted).

I do not propose to discuss the varied colours of eggs in detail. These my readers can supply from their own experience. But it is well perhaps to emphasize a few general points. Firstly, there is no connection at all between the colour of a bird and of the egg which it lays. Secondly, there is very little taxonomic significance in the colours and patterns of eggs. We may attribute a certain type of egg to a particular family and then find that such a description might almost equally apply to the eggs of a totally different group.

I have already pointed out that it is probable that all eggs are derived from an original white or pigmentless egg similar to those laid by some reptiles to-day ; and I think it is correct to consider that with eggs and nestlings there is a great deal to be said for the theory of protective colouration. With eggs it would have had two active stimulants. First of all, as we have seen, a white egg is a most conspicuous object in the open and colouration and markings must undoubtedly tend to an increase of safety. Whilst at the same time we must remember that light in excess is inimical to protoplasm. Pigment in the shell must therefore also be of importance in protecting the germinal disk from direct light.

[1] This subject has not yet been fully investigated and very little is really known about it.